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Recommended Citation

Boyce, E. G., & Lawson, L. A. (2009). Preprofessional curriculum in preparation for doctor of pharmacy educational programs. *American Journal of Pharmaceutical Education*, 73(8), 1–14. DOI: [10.5688/aj7308155](https://doi.org/10.5688/aj7308155)
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AACP CURRICULAR CHANGE SUMMIT SUPPLEMENT

Preprofessional Curriculum in Preparation for Doctor of Pharmacy Educational Programs

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The preprofessional pharmacy curriculum provides the foundation for the professional curriculum. Basic requirements are noted in the ACPE Standards and Guidelines, but there is considerable variation in the preprofessional curriculum requirements for entry into doctor of pharmacy programs in the United States. Changes in higher education, pharmacy practice, and health care continue to drive the need to evaluate the preprofessional curriculum. The objectives of this white paper were to create model preprofessional curricula that would enable students to be successful during and after entry into the professional curriculum. Using an evidence-based approach where possible, a number of factors were found to be associated with academic success during a pharmacy program and on licensing examinations. These data and other information were used to create 2 preprofessional curricular models that include the development of general and discipline-specific abilities. Challenges remain in accurately evaluating the abilities and attributes of applicants and the impact of those abilities and attributes on their success as a student and a practitioner. Colleges and schools of pharmacy should consider adopting a more consistent preprofessional curriculum on a national level. This preprofessional curriculum should be multi-dimensional, based on needs for future practice, and revised over time.

Keywords: preprofessional curriculum, prerequisites, admissions

INTRODUCTION

The types of abilities students need for success in a doctor of pharmacy (PharmD) program are readily available through documents that describe curricular outcomes and professional practice expectations, but the level of competence needed for each ability is not well described. Also, the interrelationships between the preprofessional and professional curricula need further analysis. The goal of this paper is to create a model preprofessional curricula based on analyses of the abilities (knowledge, skills, attitudes, and values) needed to be successful during and after a doctor of pharmacy program, the role of liberal education in the preprofessional curriculum, and the connections between the preprofessional curriculum and the professional curriculum.¹

Background

The preprofessional pharmacy curriculum should be designed to prepare students for the professional curriculum,

the profession of pharmacy, and active participation in society.² The preprofessional curriculum also provides information that can be used during the admissions process in attempting to select those applicants most likely to be successful. The challenges are to develop a preprofessional curriculum that adds value to the professional curriculum, meets current and future needs of the PharmD curriculum and practice, and is comprehensive without being overwhelming.

There are no data that document the impact of the preprofessional pharmacy curriculum on a pharmacy student's or practitioner's abilities. However, studies have documented the impact of select admissions factors on success or difficulty in PharmD programs or licensure.

The movement of pharmacy programs to the first-professional degree PharmD included some modest changes in admissions criteria, including an increase in the minimum preprofessional grade point average (GPA) by some programs and an increased use of interviews and writing exercises during admissions to evaluate communications abilities.³ Changes in the preprofessional curriculum were not evaluated.

The goals of this white paper are to provide guidelines for doctor of pharmacy programs to use in their evaluation and possible revision of their preprofessional requirements and criteria for admissions. These guidelines have

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been developed based on analyses and focusing on the abilities that students need to enter pharmacy programs and the profession based on current and potential future roles and responsibilities of pharmacists. Major considerations in the development of these guidelines are the recognition that student development in the preprofessional and professional curricula is strongly linked and extend well beyond formal course work.

It has been difficult to fully describe details on the level of competency needed in each of the abilities or attributes listed below. Therefore, we considered that competence was attained in a subject area if a student passed the course. Colleges and schools of pharmacy may need to place specific grade criteria on courses, particularly for areas that are associated with success or difficulty.

We present 2 models of the preprofessional pharmacy curriculum: a fundamental curriculum model and an expanded curriculum model. The fundamental preprofessional pharmacy curriculum model enables the development of abilities and attributes that are needed to prepare students for current and future PharmD curriculum, training, and practice. The expanded preprofessional curriculum model goes beyond the fundamental model to more comprehensively develop the requisite abilities and attributes and allows additional flexibility. Both curricula are time sensitive and should be reviewed and revised periodically.

The definition of the term *curriculum* will be broadened for the purposes of this paper to include the development of abilities through course work, other formal educational activities (traditionally called *co-curricular activities*), and other life experiences or informal educational activities (traditionally called *extracurricular activities*). The term *abilities* is defined in 3 domains: cognitive domain, psychomotor domain, and affective domain.

CURRENT PREPROFESSIONAL CURRICULA

Current and future needs of abilities for practicing pharmacists were based on current materials and papers from the American Association of Colleges of Pharmacy (AACP), Institute of Medicine (IOM), American Pharmacists Association (APhA), American Society of Health-Systems Pharmacy (ASHP), and other professional pharmacy organizations. Literature searches were performed primarily in the *American Journal of Pharmaceutical Education*, *Journal of Pharmacy Teaching*, and ERIC database to find articles on preprofessional curricula, admissions criteria, predictors for academic success, and undergraduate education topics and trends. Books and other resources on the trends in undergraduate and liberal arts education were also reviewed.

Standard 17.1 of the Accreditation Council for Pharmacy Education (ACPE) Accreditation Standards and Guidelines indicates that the preprofessional curriculum should include at least 2 years of university or college course work and include basic sciences courses such as general and organic chemistry, biological sciences with a focus on human processes and diseases, mathematics, informatics, communication technologies, and physical sciences (physics).² Additionally, course work in the humanities, social sciences, and communications should be required. These Standards and Guidelines do not provide recommendations on the specific abilities of applicants, but do refer to the ability to develop cognitive skills and in understanding cultural diversity.

The development of the preprofessional pharmacy curriculum has been driven by individual doctor of pharmacy programs rather than through national mandates other than accreditation standards. Additionally, studies have not comprehensively evaluated national trends in the preprofessional curriculum as many colleges and schools of pharmacy transitioned from bachelor of science in pharmacy (BS Pharm) programs to PharmD programs or enhanced general abilities (such as communications, critical thinking, problem solving) and discipline specific abilities (such as pharmacoeconomics and pharmacogenetics) within the professional curriculum. However, we can expect continued revisions in the preprofessional curriculum over time by individual programs.

The preprofessional course requirements of the PharmD programs participating in PharmCAS were collected and tabulated (Table 1).⁴ The minimum duration of the preprofessional course work was 3 or 4 semesters in 58 (82%) of the programs evaluated, 5 or 6 semesters in 10 (14%) programs, and 8 semesters (a baccalaureate degree) in 3 (4%) programs.

An analysis of the required preprofessional course work from the PharmD programs revealed 4 categories of prerequisite courses based on frequency (Table 1). At least 85% of the programs required general biology (and/or cellular or molecular biology), general and organic chemistry, calculus, and English composition or writing. The following courses were required in 50% to 80% of the programs: microbiology, anatomy, physiology, physics, statistics, public speaking, and/or interpersonal communications, economics, and unspecified courses general education, liberal arts, humanities, social sciences and/or behavioral sciences. Biochemistry and psychology and/or sociology courses were required in 20% to 30% of programs. Interestingly, 11% or fewer programs require preprofessional course work in genetics, immunology, ethics, and other cultures and/or diversity. However, other factors must be considered when evaluating these

Table 1. Courses Required for Admission Into Doctor of Pharmacy Programs in the United States (N = 71)

Courses Required	Required, No. (%)
General, Cellular and/or Molecular Biology ^a	67 (94)
Microbiology	46 (65)
Anatomy	44 (62)
Physiology	38 (54)
Genetics	4 (6)
Immunology	3 (4)
General Chemistry	71 (100)
Organic Chemistry	71 (100)
Biochemistry	14 (20)
Calculus	68 (96)
Physics	54 (76)
Statistics	40 (56)
Public Speaking and/or Interpersonal Communications	44 (62)
English Composition and/or Writing	61 (86)
Economics	42 (59)
Psychology and/or Sociology	19 (27)
Ethics	4 (6)
Other Cultures and/or Diversity	8 (11)
Fine Arts	8 (11)
Other but unspecified General Education, Liberal Arts, Humanities, Social Sciences and/or Behavioral Sciences	55 (77)

^a Four programs; other programs require Anatomy & Physiology. Data are from PharmCAS, the Pharmacy College Application Service from the American Association of Colleges of Pharmacy. Available through <http://www.pharmcas.org/>

frequencies. Course names may not reveal the total content of the course. For example, general biology courses may include considerable coverage of cellular and molecular biology and genetics. Additionally, some general abilities (such as communications, ethics, and cultural competence abilities) may be developed across a set of general education courses in the preprofessional curriculum instead of within specifically named courses. Furthermore, some programs may include courses such as immunology in the professional component of the program rather than in the preprofessional component.

UNDERGRADUATE EDUCATION

Trends in Undergraduate Education

Undergraduate education has gone through many changes over the last decade in attempts to enhance the undergraduate experience and learning. These changes have been driven by evidence-based educational research, the need to perform assessment, and results from national surveys on student engagement and satisfaction.

Recent trends in undergraduate education have focused on restructuring the learning process, enhancing the development of certain abilities or attributes, and continuing to increase the use of technology.

Attempts have been made to enhance learning by altering the structure of the learning process. Major trends have included the development or increased use of active and interactive learning, cooperative learning,⁵ collaborative learning, learning communities, immersion, holistic learning, and small group learning strategies and methods. Small group learning and combined active-cooperative learning have enhanced learning, student attitude toward learning, and increased persistence in math and science curricula.^{6,7} Interactive educational methods appear to enhance problem-solving abilities.⁸ Many universities have developed learning communities, which appear to enhance the development of abilities and retention.

Many specific abilities and attributes have been the focus of innovations in higher education. Examples include the development of leadership abilities, critical-thinking skills, societal responsibility, and social and emotional intelligence. Colleges and universities have used various means of developing these abilities in students, including requiring specific courses for all students to take or allowing for students to choose from select menus of courses that target those abilities. Some institutions have developed individual or a series of required general education/liberal arts courses that target development of several specific abilities. Examples of required undergraduate courses that develop multiple abilities include a freshman seminar or intellectual heritage course (or course series) required in the first year, service-learning as a general requirement, and senior seminar or capstone courses required at the end of the undergraduate program.

Extracurricular or co-curricular activities that focus on serving surrounding communities are now common at universities and colleges. These activities meet the mission and goals of the university or college and can be managed through academic departments, administrative offices, and/or student organizations. Students may develop or enhance their abilities in social responsibility, empathy, leadership, teamwork, specific discipline or service, and other aspects during these activities. Service learning may also be a component of extracurricular or co-curricular activities.

Universities and colleges continue to enhance the learning environment and the components used to facilitate learning. The use of technologically advanced classrooms enable faculty members to use a variety of teaching and learning methods to enhance understanding and benefit students with different learning styles. Such classrooms can also be used to create an efficient method to

provide learning simultaneously in local and distant sites as well as instantaneous formative assessments. Classroom design has also been focused on enabling instructor-student and student-student interaction and engagement. There has been an increased use of courseware or software that enables the collection, distribution, and use of course material and interaction and communication among students and faculty members by synchronous and asynchronous means.

Liberal Education and the Liberal Arts

A liberal education is meant to prepare students for the complexity, diversity, and change encountered in society and life through a broad education in addition to specialized education in a field of interest.⁹ A liberal education should develop social responsibility and skills in communication and problem solving. The liberal arts enhance general knowledge and intellectual abilities through studies in language, literature, history, philosophy, fine arts, and science.^{10,11} Others have defined the liberal arts as a well-rounded education in the humanities, arts, and sciences.^{9,12} These general abilities from the liberal arts are considered separate from professional or vocational abilities, but do enhance professional and vocational abilities. The role of a liberal education in the preprofessional and professional curriculum is to enable the student to achieve academic, professional, and societal success in the professional educational program; practice as a pharmacist; and become engaged as an informed citizen.

GENERAL ABILITIES

Some general abilities are considered to be fundamental for students entering doctor of pharmacy programs, including communication, collaborative and interactive critical-thinking, problem-solving, decision-making, and self-learning abilities.¹³ Measurements of the level of ability or performance in many of these general abilities have been associated with academic and/or postgraduate success, as noted below. General abilities are defined as those abilities that are needed or desirable in the development of any professional. This section provides an overview of data, perceptions, and the potential impact of undergraduate education on the development of the specific general abilities that have been identified as needed or desired upon entry into a PharmD program.

Communication Abilities

Communication abilities are essential for success in a PharmD program and as a pharmacist. Communication abilities of applicants have been evaluated through Phar-

macy College Admissions Test (PCAT) subtest scores, essays, small group exercises, and interviews. Student performance in pharmacy programs correlates with communication abilities (essay, PCAT verbal, and reading subtest scores),¹³⁻¹⁵ but does not fit into a multiple regression model of first-year pharmacy GPA, academic standing, and whether students failed a pharmacy course in a historically black school of pharmacy.¹⁶ Many colleges and schools of pharmacy evaluate communications abilities as part of the admissions process.^{3,17-19} PCAT verbal subtest scores correlated with overall pharmacy GPA in all pharmacy students in 1 program and in African American and Asian pharmacy students in another program,^{20,21} but not with first-year pharmacy GPA in another study.²² PCAT reading subtest scores correlated with first-year pharmacy GPAs in some¹⁵ but not all studies.²² Scores from structured interviews, scores on writing samples, and scores on a verbal standardized multiple-choice test have also correlated with academic performance.¹⁷ PCAT verbal subtest scores correlated with performance on the North American Pharmacist Licensure Examination (NAPLEX).²³ Students who have English as a second language or not their best language may not fully understand common and basic terms used in pharmacotherapeutics course examinations.²⁴ However, English as a second language was not a factor in predicting overall pharmacy GPA or success in another pharmacy program.²⁰

Written communication skills were ranked among the top 5 most important preprofessional attributes for pharmacy students.²⁵ Writing skills are critical for the development of information used in educational activities, patient education, formulary decisions, documentation of pharmacy services, and other activities. Scores on admissions essays have correlated with performance in traditional and nontraditional (distance- or Internet-based) PharmD programs.^{14,26} There also may be a strong association between writing skills and critical-thinking skills.¹³

Reading skills are important in PharmD programs and practice as a pharmacist. The PCAT reading subtest score correlates with cumulative pharmacy program GPA.²⁰ An analysis of third-year PharmD students at 1 school of pharmacy revealed that their average vocabulary, comprehension, and composite grade levels were 16.4 to 16.5, but individual students ranged from 9.3 to 18.9 using the Nelson-Denny Reading Test.²⁷ However, readability grade levels for required pharmacotherapy textbooks averaged 18.1 (range 16.3 to 19.5), for medical guidelines averaged 19.2 (range 17.5 to 21.0), and for select medical journals reportedly averaged 16.85 to 17.8 as calculated using the Gunning FOG readability formula. These findings were consistent with findings that the reading grade

level of medical interns was also lower than the readability grade level of medical journals. Nelson-Denny Reading Test determined grade equivalents for vocabulary, comprehension, and composite all correlated with PCAT reading subtest scores.

Oral communication skills were ranked among the top 5 most important preprofessional attributes for pharmacy students.²⁵ Other than data from studies on interviews and nonnative English speakers provided above, little research has been done to determine the impact of oral communications skills at admission on performance during or after the pharmacy professional curriculum.

Interactive Abilities

Interactive skills have become more important in education and practice environments.¹³ Problem-based learning, small group projects, problem-solving courses, and experiential courses focus on group interaction. The future of patient care is based on team-based care.²⁸ As noted above, many universities and colleges have implemented general methods to enhance interaction skills through cooperative learning, collaborative learning, learning communities, small group learning, and service learning. Interaction abilities of applicants have been evaluated through small group exercises and interviews.

Leadership skills are also important attributes for incoming pharmacy students.²⁵ However, it is unclear whether leadership abilities are associated with success during or following a PharmD program. There is no universally accepted definition of leadership. Additionally, not everyone can be *the* leader as there is only room for one leader. Perhaps leadership should be defined on a continuum, including leadership attributes that are needed in followers as well as leaders. The lack of universality of a definition of leadership has made it difficult to study, particularly in applicants to the professional pharmacy program.

Scores on personal relations, sociability, emotional stability, and ascendancy (activity, self-assurance, and independence in groups) scales from the Gordon Personal Profile-Inventory were not different between pharmacists who were active (serve as preceptors, active in professional organizations, pursue additional education) compared to those who were nonactive.²⁹ Students scored lower on the personal relations, emotional stability, and ascendancy scales and higher on the sociability scale than pharmacists, but it is unclear how these attributes are developed and whether preprofessional scores on these scales would be associated with performance in a PharmD program or as a pharmacist.

Online social networking continues to expand, with estimates that 80% to 90% of university and college students have accounts on a social networking site.³⁰ Social

networking sites enhance social interactions and may help students to develop their own identity, find their place in the university or college social network, and continue their enrollment stay in school. However, postings by students on these sites may also document (through photographs or written comments) inappropriate or illegal behaviors. Heavy use of a social networking site has been associated with lower GPAs in college students living on campus. However, it is unclear whether social networking is associated with performance during or following pharmacy or other professional degree programs.

Cognitive Abilities

Critical-thinking skills are thought to be important for both the delivery of pharmacy-based care and progression through PharmD programs.^{13,25} Critical-thinking abilities in incoming pharmacy students may be crucial since it is difficult to document improvement in critical-thinking abilities even following courses or curricula that attempt to develop critical-thinking abilities. However, the impact of preprofessional scores in critical thinking on performance in PharmD programs and practice is unclear. Preprofessional scores on a standardized critical thinking scale (Watson-Glaser Critical Thinking Appraisal) did not correlate with performance in a PharmD program.³¹ However, scores on different critical thinking scales (California Critical Thinking Skills Test, California Critical Thinking Disposition Inventory) correlated with overall PharmD GPA, first- to third-year GPA, GPA in advanced pharmacy practice experiences (APPEs), and/or scores on the NAPLEX.^{14,23}

Motivation to use critical-thinking skills may be even more important.¹³ Pharmacists who served as preceptors, were active in pharmacy organizations, and completed additional education had higher scores in original thinking (intellectual curiosity and enjoyment of difficult problems, thought-provoking questions, and thinking about new ideas, from the Gordon Personal Profile-Inventory) than nonactive pharmacists.²⁹ Pharmacy student scores on the ratings were lower on the original thinking scale than pharmacists, but it is unclear how this trait is developed and whether a higher preprofessional score on this scale is associated with performance in a PharmD program or as a pharmacist.

Ethics and Moral Reasoning

Ethics and moral reasoning abilities are needed on admission into the professional curriculum because of the likelihood that students will be exposed to ethical dilemmas during on-campus courses, introductory pharmacy practice experiences, professional organization activities, and pharmacy work experiences. These abilities

will also be further developed during the professional curriculum. Ethics was ranked among the top 5 most important preprofessional attributes for pharmacy students.²⁵ High moral reasoning, measured using the Defining Issues Test, was associated with higher abilities in clinical reasoning in practitioners,³² but was not associated with performance in a PharmD program.³¹ Interestingly, pharmacy students and practitioners scored lower on moral reasoning tests than medical and dental students.³² Moral reasoning can be part of the admissions criteria despite some difficulties in evaluating this attribute.

Relatively recent movements in higher education have been to include coursework in ethics and moral reasoning as a general education requirement, to incorporate a strategy of ethics and moral reasoning across the undergraduate curriculum and/or student life, and to include development of ethics and moral reasoning within most degree programs (business, education, biology, computer science, etc) as standalone courses or components of discipline-specific courses. There are a wide variety of approaches, but it is unclear which one is best and how much impact can be demonstrated in ethics or moral reasoning in the preprofessional and professional curricula.

Cultural Competence and Diversity Awareness

Cultural competence and diversity awareness are important in undergraduate and pharmacy education.² Liberal education and general education at the vast majority of universities and colleges include requirements and elective opportunities for the development of understanding other cultures and diversity. It is unclear how a student's preprofessional development of cultural competence and diversity awareness will influence their success as a student and professional. However, it is likely that such competence and awareness is associated with other desirable attributes such as caring and communication skills.

Societal Responsibility

Most universities and colleges appear to address the importance and development of social responsibility and informed citizenship through required or elective courses or through extracurricular activities. These are important attributes for pharmacy students and pharmacists to meet the needs of society as professionals and citizens. Guideline 17.3 of the ACPE Standards and Guidelines states that

Admission criteria, policies, and procedures should take into account necessary scholastic accomplishments, as well as other desirable qualities (such as intellectual curiosity, leadership, emotional maturity, empathy, ethical behavior, motivation, industriousness, and communication capabilities) that support the student's potential to become a self-directed life-

long learner and an effective professional. ...In-person standardized interviews of applicants, including evaluation of verbal communication skills, understanding of the pharmacy profession, and commitment to patient care, must be part of the admission process.²

Many schools incorporate an assessment of affective or professionalism qualities in the admission process through the use of personal interviews or essays. Applicants can sometimes "fake" responses knowing what characteristics are desirable. Concerns about using these characteristics in making admission decisions also include the possibility of being discriminatory, the validity and reliability of instruments to measure these attributes, and the potential resultant decreased emphasis on academic preparation. A standardized assessment of affective qualities has been developed to identify applicants with characteristics such as community service orientation, empathy, helping orientation and responsibility.¹³ Scores on this instrument were a significant predictor of academic success in their curriculum. Ratings from a similar instrument using forced-choice self-descriptions of empathy were more predictive of program performance in simulated patient-pharmacist interactions than a more traditional self-rating approach.³³

A survey of 52 colleges and schools of pharmacy examined how student professionalism was assessed and enhanced.³⁴ In the recruitment and admissions phases, 75% of respondent programs indicated that prospective students were screened to determine their potential for professional development. However, only 26% of the programs used a standard instrument. Ninety percent of the respondents did consider an applicant's potential for professional development in the admissions process.

Community service and service-learning projects are increasingly being required or recommended in high school and college curricula. Little or no data are available on the value, validity, or reliability of these activities in the admission process or development of professionalism.

Perhaps the most practical approach to determine motivation to become a pharmacist and understanding of the profession would be to assess the time and money spent, and the depth and breadth of knowledge possessed.¹³ Review of a resume and an interview can determine what an applicant has invested in learning about or working in a pharmacy. The impact of prior work experience in a pharmacy on overall success in a pharmacy academic program is unclear. However, no or little work experience in pharmacy prior to entering the professional program has been associated with decreased performance in a course on the top 200 drugs (Greene, Nuzum, and Boyce. Unpublished data. June 2009). Although shadowing or interacting with pharmacists or other health care

professionals or volunteering in a health care setting seems desirable when evaluating an applicant, it is unclear whether these activities are associated with success in the professional program. Additionally, there is little or no data on, or even a commonly accepted definition of “understanding the pharmacy profession” or “commitment to patient care.”

Other Personal Abilities and Attributes

Personal attributes that appear to be desirable for entering pharmacy students include maturity, motivation, compassion, empathy, integrity, altruism, respect, responsibility, service orientation, good work habits, emotional intelligence, and interpersonal relationship skills.^{25,35} Character and motivation were each ranked among the top 5 most important preprofessional attributes for pharmacy students.²⁵ Attributes that have been associated with performance in professional pharmacy courses include self-efficacy (the student’s ability to estimate their own performance) and possibly motivation.^{36,37} However, scores on the Gordon Personal Profile-Inventory scales for responsibility, cautiousness, and vigor were not different between pharmacists who were active (served as preceptors, active in professional organizations, pursued additional education) compared to those who were nonactive.²⁹ Students scored lower on these scales than pharmacists, but it is unclear how these attributes are developed and whether or not preprofessional scores on these scales would be associated with performance in a PharmD program or as a pharmacist. Emotional intelligence may be a better predictor of career success than intelligence quotient.^{38,39} Empathy is a desirable trait for pharmacists and should also be considered during admissions.²⁵ The assessment of empathy through forced-choice self-descriptions of empathy was a stronger predictor of empathy scores in simulated patient-pharmacist interactions compared to direct self-ratings of empathy.³³ Many of these attributes and characteristics may provide insights into a student’s future development in professionalism. Professionalism is generally evaluated after entry into the professional curriculum, but methods used to measure professionalism may provide useful insights during the evaluation of applicants.^{40,41}

Research skills are desirable for students entering a PharmD program, but only 25% of programs responding to a survey required completion of a research project as part of the program.⁴² Research skills are developed in PharmD programs at various levels, but incoming students should have an understanding of the scientific method and statistics (see below).

It is unclear whether age is a factor in program performance. Some studies have found that age was in-

versely correlated with first-semester or first-year GPA in a PharmD program,^{16,43} while other studies found no correlation.^{22,44} Students who graduated and passed the NAPLEX were younger than the combined group of those who did not graduate or graduated but failed the NAPLEX.²³ This study also found a trend ($p > 0.05$) for an inverse association between age and NAPLEX scores.

CONTENT-SPECIFIC ABILITIES NEEDED

Prior work on determining an appropriate preprofessional curriculum for pharmacy students included a survey of deans and other academic administrators of colleges and schools of pharmacy using a 5-point Likert scale (from 1 = strongly disagree to 5 = strongly agree).¹⁷ There was reasonably strong agreement that the preprofessional curriculum should include (average rating from 5.0 to 4.0, listed from high to low) general and organic chemistry, general biology, English composition, calculus, anatomy and physiology, public speaking, and microbiology courses. There was moderate agreement (average ratings of 3.9 to 3.3) that the preprofessional curriculum should include statistics, biochemistry, ethics, physics, cellular biology, English literature, molecular biology, genetics, sociology, immunology, and business courses. Ratings were neutral (average ratings of 3.2 to 2.8) for foreign language, political science, fine arts, and zoology courses. Ratings were not supportive (average ratings less than 2.8) for requiring bacteriology, physical education, geography, physical chemistry, music appreciation, anthropology, and religion courses in the preprofessional curriculum. There was moderate agreement that preadmission evaluations should include the PCAT (mean rating of 3.4) and other professional testing (mean rating of 3.5). Professional testing performed during admissions included a writing sample and problem-solving exercises or other sample exercises. These data are useful in the development of a preprofessional curriculum and in the development of a set of abilities needed prior to entry into the doctor of pharmacy curriculum. Studies have attempted to determine factors that predict performance, success, or difficulty in the PharmD program. The preprofessional combined math and science GPA correlates with academic performance, as measured by GPA, in the first semester or first year for students in both standard (traditional) and distance pathways of PharmD programs,^{22,43,45} and with performance in a pharmacy administration course.³⁶ Preprofessional science GPA fit into multiple-regression models of academic standing and whether or not students failed a pharmacy course in a historically black school of pharmacy.¹⁶ However, preprofessional grades in biology, chemistry, and mathematics courses did not correlate with scores on the NAPLEX.²³

Should the prepharmacy curriculum include earning a baccalaureate degree? The answer is unclear. There was no consistent agreement on the length of the preprofessional curriculum or whether a baccalaureate degree should be required in the survey of pharmacy program administrators.¹⁷ Performance or success in the first semester or first year of a PharmD program as measured by GPA was associated with having earned a baccalaureate degree or an associate degree prior to entering the pharmacy program.^{22,43,45} Additionally, having a previous degree fit into multiple regression models of first-year pharmacy GPA and academic standing, but not a model of whether students failed a pharmacy course in a historically black school of pharmacy.¹⁶ However, having a baccalaureate or masters degree did not correlate with scores on annual progress testing or the NAPLEX.^{23,46}

Chemical Sciences

Knowledge in general and organic chemistry are fundamental in the development of knowledge of the chemistry, pharmaceuticals, compounding, and action of drugs. Although academic pharmacy administrators perceive a need for biochemistry as part of the preprofessional curriculum, few programs have such a requirement (Table 1).¹⁷ Many PharmD curricula include biochemistry courses or content in the professional curriculum.

The PCAT chemistry subtest score and preprofessional chemistry GPA correlated with overall pharmacy GPA, performance in a pharmacy administration course, and performance on the NAPLEX,^{20,23,36} but not with first-year pharmacy GPA.²² However, the PCAT chemistry subtest score fit into a multiple regression model of first-year pharmacy GPA, academic standing, and whether students failed a pharmacy course in a historically black school of pharmacy.¹⁶ Grades in organic chemistry have been associated with first-year success and failure in a pharmacy program.⁴⁵ Advanced course work in chemistry and taking organic chemistry at a 4-year institution were associated with higher PCAT chemistry subtest scores.²³ Performance on NAPLEX was associated with the PCAT chemistry subtest score, but not with taking advanced chemistry courses prior to entering the professional program.²³ Additional analyses found no difference in taking preprofessional advanced chemistry courses when comparing those who graduated and passed the NAPLEX with a combined group of students who did not graduate or graduated but failed the NAPLEX.²³

Biological Sciences

The general biological sciences, including at least some knowledge in cellular and molecular biology, are needed in PharmD curricula for the development of un-

derstanding of biopharmaceutics, pharmacology, pathophysiology, and therapeutics. Microbiology, anatomy, and physiology are commonly, but not consistently preprofessional requirements (Table 1), but are also needed in understanding pharmacology, pathophysiology, and therapeutics. Additionally, a small fraction of pharmacy programs require genetics and/or immunology in the preprofessional curriculum. The inclusion or exclusion of these other biological sciences in the preprofessional curriculum is likely to determine what is covered in the professional curriculum. Unfortunately, there are no data to indicate whether preprofessional requirements or performance in these other biological science courses is associated with success as a pharmacy student or pharmacist.

Preprofessional biology course GPA met the criteria to become a variable in the discriminate analysis multivariate model for predicting first-year GPA and correlated with the cumulative pharmacy GPA, but did not correlate with first-year pharmacy program GPA.^{15,20} Advanced course work in biology was associated with higher PCAT biology subtest scores.²³ PCAT biology subtest scores were associated with overall pharmacy GPA,²⁰ but not with first-year pharmacy GPA in another study.²² Performance on the NAPLEX was associated with PCAT biology subtest scores but not associated with taking advanced biology courses prior to entering the professional program.²³ Additional analyses found no difference in taking preprofessional advanced biology courses when comparing those who graduated and passed the NAPLEX with the combined group of those who did not graduate or graduated but failed the NAPLEX.

Mathematics and Statistics

Mathematics skills are likely to be important during and after the PharmD curriculum in performing drug dosing, pharmacokinetic, and other calculations.¹³ Calculus is preferred to more fully understand pharmaceuticals, pharmacodynamics, and pharmacokinetics content in the professional curriculum. Basic mathematics skills, measured using a standardized test, were found to correlate with math-science GPA, PCAT composite score and quantitative subtest score, and performance in a first-year pharmacy calculations course.⁴⁷ First-year and overall pharmacy GPA each correlated with preprofessional mathematics course GPA and PCAT quantitative or mathematics subtest scores in some but not all studies.^{15,20,22} Advanced course work in mathematics was associated with higher PCAT quantitative subtest scores.²³ Performance on the NAPLEX was associated with PCAT quantitative subtest scores but not with advanced mathematics courses prior to entering the professional program. Additional analyses found no difference in taking

preprofessional advanced mathematics courses when comparing those who graduated and passed the NAPLEX with the combined group of those who did not graduate or graduated and failed the NAPLEX.

A course in statistics is a required component of the preprofessional curriculum in 56% to 69% of the PharmD programs (Table 1).⁴² The knowledge of statistics is important to more fully understand research and its application to therapeutics and practice.

Information Technology

Information technology skills are increasingly important in the education and practice of pharmacy.¹³ The development of information technology skills has been shifted, at least in part, to primary and secondary education. These skills do not routinely appear as separate courses in general education requirements. However, information technology skills are developed during orientation to the library and throughout many undergraduate curricula.

Humanities and Social Sciences

The humanities include literature, languages, philosophy, arts, and history. These are part of the liberal arts. Communication, ethics, moral reasoning, and critical thinking abilities are components of humanities and important abilities for pharmacy students and practitioners,² as described above. Abilities in other humanities are essential to enable the full development of a fully engaged professional and citizen. Fulfillment of general education requirements at the vast majority of colleges and universities should satisfy these needs.

The social sciences include psychology, sociology, economics, law, political science, and anthropology. Abilities within several of these areas are essential components of the preprofessional curriculum, whereas others are important but perhaps not essential. Although currently required specifically by only 27% of the programs surveyed (Table 1), sociology and psychology should be considered essential in the preprofessional curriculum. Knowledge of psychology is essential in better understanding working with and influencing others, the potential psychiatric impact of illness, and psychiatric diseases themselves. A foundation in sociology also is essential to enhance student understanding of the roles and responsibilities of health care professionals and organizations in society. A solid foundation in economics is also needed so that students are able to expand and apply their understanding of the basic economic concepts to pharmacoeconomics and medical economics. Course work in macroeconomics and/or microeconomics was required in 50% of preprofessional curricula (Table 1). An under-

standing of the basic elements of law is very beneficial, particularly given the regulations that govern pharmacy practice and the litigious nature of the health care environment. Abilities in political science are also beneficial, but not essential, in enabling students to better understand the political arena so that they can understand the needs and potentially participate in attempts to enhance health care and pharmacy practice through laws and regulations.

The studies that evaluate the impact of preprofessional abilities in select humanities and social sciences on the performance of pharmacy students or pharmacists are listed in other sections of this paper. However, these studies have not evaluated the relationships of many of these abilities, particularly those in psychology, sociology, and economics.

ACADEMIC ABILITY

Learning and Study Strategies

Learning and study strategies are likely to be associated with academic success in the preprofessional and the professional curriculum. However, performance in the first semester and first year of a PharmD program, measured by GPA, did not correlate with scores on a standardized instrument (the Learning and Study Strategies Inventory) to measure these strategies.³¹ It is unclear whether it is the nature of the instrument, the lack of any impact, or the admissions process that selects students with similar learning and study strategies or abilities.

Academic Performance

Academic performance is a consideration for entry into PharmD programs since many, but not all,^{14,22} studies have documented a correlation between the preprofessional and the professional program GPA.^{13,15,20,43,45} Preprofessional overall GPA fit into a multiple regression model of first-year pharmacy GPA, but not regression models of academic standing and whether students failed a pharmacy course in a historically black school of pharmacy.¹⁶ The preprofessional GPA was not correlated with performance on annual progress testing.⁴⁶ Interestingly, the preprofessional required course GPA was not associated with pharmacy program GPA, but was even less correlated than cumulative preprofessional GPA.¹⁴ Minimum accepted preprofessional GPA ranges from 2.0 to 3.0 (overall mean of 2.5 to 2.6), but the actual entering average GPA ranges from 2.9 to 3.7 (mean of 3.3).³ Preprofessional GPAs were correlated with scores on the NAPLEX in one study but not in another.^{23,48}

MAKING CONNECTIONS

Connections between the preprofessional and professional programs can differ based on physical location of

institutions offering the programs and the presence of a formalized relationship between the 2 entities. The pre-professional program has a major effect on the content of the professional program with regard to course requirements. Communication between the student with pharmacy faculty members and administrators will be affected by location of programs and formalized relationships. Teaching and learning methodologies and techniques may differ or be in congruence between the preprofessional and professional pharmacy programs. The culture of the learning environment and the opportunity to participate in various activities and/or experiences may differ as well.

Prepharmacy Programs at Institutions with Doctor of Pharmacy Programs

For those institutions offering a PharmD program, communication, facilitation, and collaboration between faculty members of preprofessional and professional coursework is easier. Communication is enhanced due to ease of interactions and general knowledge of institutional offerings. The potential for collaborating and relating preprofessional and professional coursework and requirements is enhanced. In some cases, potential applicants may even be able to enroll in a preprofessional course taught by pharmacy faculty members. With optimal course selection, a potential applicant might be able to complete a second major or a minor while earning the PharmD degree.

A single institution may have institution-wide philosophies or policies regarding teaching and learning methodologies, thus allowing for a smoother transition to professional coursework. Potential applicants find it easier to obtain information about the pharmacy program and have a better knowledge of the program due to accessibility to faculty members and pharmacy students. The admission process may be less anxiety-provoking, easier, and more efficient because the PharmD program is offered within the same institution.

Potential applicants in the prepharmacy program may have the opportunity to participate in student pharmacy organizations and events. Interaction with pharmacy students on campus provides more opportunities to learn about the profession and what is involved in becoming a health professional.

Prepharmacy Programs at Institutions Affiliated With Institutions Offering Doctor of Pharmacy Programs

Some institutions offering PharmD programs have developed formal affiliation agreements with other institutions that offer prepharmacy programs. In one instance,

a combined “3-4” program results in students earning both the bachelor of science (BS) degree, usually in biology, chemistry or biochemistry, from one institution and the PharmD degree from the other institution.⁴⁹ The benefits of this approach are enhanced recruitment and knowledge of the pharmacy program. Many such arrangements guarantee a number of seats in the pharmacy program for qualified applicants from the prepharmacy program, thereby easing some anxiety associated with the admission process.

Usually, coursework preapproved or chosen by the pharmacy program makes choice of coursework in the preprofessional program easier and simpler for the potential applicant. The transition to the pharmacy program may be easier as problems have already been identified and solved.

Prepharmacy Programs at Institutions That Do Not Have and Are Not Affiliated with Doctor of Pharmacy Programs

Potential applicants from institutions that do not have and are not affiliated with a PharmD program must work harder to find information about pharmacy programs and identify appropriate prepharmacy coursework. They must prospectively identify programs of interest and communicate with these programs well ahead of application deadlines. Opportunities to interact with pharmacy faculty members and students would not be available and learning about the culture of the profession may be difficult or not available. Alternatively, the opportunity to be involved in more diverse experiences may be found at an institution without any affiliation with pharmacy. Having students with varied background and experiences would bring diversity and richness to the pharmacy student class.

SUMMARY OF FINDINGS

There is considerable variation in the preprofessional pharmacy curricula, which may parallel some variation in the professional curricula. We prefer more standardized preprofessional curricula to provide more consistent direction for applicants and for colleges and schools of pharmacy. The preprofessional curriculum should develop the general and specific abilities needed to be successful as a pharmacy student and practitioner. Changes in undergraduate education contain many elements that appear to better prepare students for entry into the professional curriculum. The major factors associated with success in the professional pharmacy curriculum and/or licensing examination include undergraduate performance, motivation, community service orientation, and abilities in communications, critical thinking, empathy, chemical sciences, biological sciences, and mathematics. Other

abilities or attributes that appear to be important but have not been associated with success in a PharmD program include interaction, leadership, cultural competence, diversity awareness, understanding of the pharmacy profession, emotional intelligence, technology, humanities, social sciences, and learning and study strategies. Additionally, the preprofessional curriculum and professional curriculum need to be coordinated with each other and revised when needed to keep pace with current and future needs.

Although 82% of programs require 4 semesters of preprofessional course work, it may take 5 or 6 semesters for many students to meet these requirements based on the number and sequencing of courses needed. Competitiveness for entry into PharmD programs has resulted in admitting students with transcripts that markedly exceed the minimum preprofessional requirements.

The basic elements of the current preprofessional course requirements (general biology, general and organic chemistry, calculus, composition) for the vast majority of pharmacy programs seem very similar to requirements over the last 1 to 2 decades. Other courses required in more than 50% of programs (microbiology, anatomy, physiology, physics, statistics, public speaking and/or interpersonal communications, economics, and unspecified courses in general education, liberal arts, humanities, social sciences and/or behavioral sciences) appear to be fundamental, as well. Although not commonly components of preprofessional curricula, courses in biochemistry, psychology, sociology, genetics, immunology, ethics, and other cultures and/or diversity would also seem appropriate in preprofessional curricula. Developing an appropriate balance of general and specific abilities is essential.

The following recommendations are based on the data provided above, but also on other factors. The vast majority of the measures of success provided in the literature and described are limited to GPAs and passing licensing examinations. Other measures of success need to be considered, including success in patient care, pharmacy practice settings, professional organizations, and public health and community service settings during the professional curriculum and following graduation.

RECOMMENDATIONS

General Recommendations

We recommend that the colleges and schools of pharmacy use completion of preprofessional course work (outlined below) and indicators of academic performance, general abilities (communications, critical thinking, moral reasoning, interaction, cultural competence), and other attributes when evaluating applicants for admissions to the pharmacy professional program. The strong

association of preprofessional GPA with performance in the professional program supports its continued use in admissions decision, but additional criteria should also be used. Although not well studied, colleges and schools of pharmacy should consider grading criteria for specific required preprofessional course work, such as requiring a minimum grade of B. The PCAT appears to be a reasonable method of assessing content-specific and general abilities in addition to being useful in admissions decisions. However, programs should determine whether or not PCAT subtest scores add value beyond grades in specific courses to predict success or difficulty in the professional curriculum. An analysis of feeder schools' courses, curricula, and students may also provide insights for use during admissions deliberations.

An evaluation of an applicant's general abilities should minimally include an interview that provides at least an evaluation of on demand oral and written communication abilities. Interviews should be structured to determine at least a few of the following: thinking abilities, motivation, interaction abilities, knowledge of the pharmacy profession and/or health care, thinking abilities, and desirable attributes (caring, empathy, leadership, social responsibility, etc). Structured interviews by trained interviewers may be useful, but standardized instruments should also be considered and evaluated for use in the admissions process. An evaluation of each of these methods is beyond the scope of this white paper, but some examples are provided above. Efforts should be made to study the use of methods to evaluate these attributes and the impact of those attributes on success as a pharmacy student and graduate.

Fundamental Preprofessional Curriculum and Activities

The fundamental preprofessional curriculum and activities should include a liberal education, a foundation in the sciences and mathematics, and general appreciation of pharmacy as a health sciences profession. Many colleges and schools of pharmacy should review and, if necessary, enhance their requirements to provide a full spectrum of liberal education components. We recommend courses in English composition, public speaking or interpersonal communications, psychology, sociology, economics, and general education requirements that include US culture and global/international studies (Table 2). Students should also have been exposed to ethics, moral reasoning, cultural competence, diversity awareness, group interaction, and critical thinking through their course work. Finally, students should have worked or volunteered in a pharmacy setting (or at least a health care setting) to have developed a perspective on pharmacy. The preprofessional science

Table 2. Courses in the Fundamental and Extended Preprofessional Curricula

Course(s)	Comment	Semester Courses ^a
Recommended		
General Biology	With laboratory	2
Microbiology	With laboratory	1
Human Anatomy and Physiology		2
General / Inorganic Chemistry	With laboratory	2
Organic Chemistry	With laboratory	2
Calculus		1
Physics		1
Statistics		1
Economics (general economics, microeconomics, or macroeconomics)	Prefer both microeconomics and macroeconomics	1
Composition		1
Communication – interpersonal or public speaking		1
Psychology		1
Sociology		1
Other General Education Requirements (US culture, global / international studies, cultural competence / diversity awareness, ethics and moral reasoning, group interaction, others)		Varies
Additional Courses Recommended for the Extended Preprofessional Curriculum		
Genetics		1
Biochemistry		1
Immunology		1
Completion of both Macroeconomics and Microeconomics		1 additional
Completion of All General Education Requirements		Varies

^a Semester Courses: Number of courses needed based on a semester system. For a quarter system, 2 semester courses are equivalent to 3 quarter courses. The unit value of these courses will generally vary from 3 to 5 depending on traditional course design.

and mathematics curriculum should include general biology that also focused on cellular biology, general and organic chemistry, calculus, physics, statistics, microbiology, anatomy, and physiology (Table 2). These courses should also focus on the development of inquiry and the scientific method. The duration of this preprofessional curriculum is more likely to equate to at least 5 semesters of course work for most students.

Extended Preprofessional Curricula and Activities

Colleges and schools of pharmacy should consider extending the preprofessional curriculum to include the development of a more standardized and complete set of courses and experiences. The preprofessional curriculum probably should be at least 6 semesters long and will likely lead to the attainment of a baccalaureate degree, given the broad spectrum of courses we propose for the expanded preprofessional curriculum. We feel this is necessary to develop the full range of abilities and attributes

needed for success as a student and practitioner. The completion of the baccalaureate degree is likely to enhance the student's general abilities, but will also enhance their maturity and demonstrate their ability to complete a program. The additional science courses to be added to the fundamental preprofessional curriculum include biochemistry, genetics, and possibly immunology (Table 2). Such a curriculum would also enable the more complete development of general abilities and a liberal education.

Such system-wide changes should not be taken lightly and will require considerable discussion and resolution. These changes would require marked changes in a number of PharmD programs that have prepharmacy programs at their own or affiliated institutions.

Enhancements and standardization in the preprofessional pharmacy curriculum has the potential to continue to advance the abilities of pharmacy students, and eventually, pharmacists. Efforts should be made to expand the preprofessional curriculum to more completely develop

general and specific abilities that reflect educational and practice needs.

ACKNOWLEDGEMENTS

We wish to thank Robert “Buzz” Kerr and Jim Uchizono for their help in developing the general concepts and initial outline for this white paper. We also wish to thank Cecilia Plaza, Gary Oderda, and the reviewers for their assistance, insights, and direction.

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